SOIL CONDITION AND NUTRITIONAL FACTORS

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Investigations on soil conditions and nutritional factors associated with root (wilt) disease of coconut was started in 1939. Menon and Nair (1949) presented the first report on this aspect based on a survey and study of the disease in relation to soil conditions. They observed that the disease affected soils were generally poor in major nutrients especially potash. The affected soils were generally acidic with low content of exchangeable bases and poor base exchange capacity. Silica sesquioxide ratio was also slightly higher in these areas. Similar results were obtained from a more systematic study by Menon and Nair (1952). Sankarasubramony, Pandalai and Menon (1951) ruled out the possibility of association of manganese deficiency or toxicity with the disease. It was also indicated that even at the level of 434.8 ppm of Mn in the soil, there was no toxic effect on the palm. A more intensive study on the major soil groups of erstwhile Travancore-Cochin, covering disease affected and healthy pockets was conducted by Sankarasubramony et al (1954, 1955, 1956) and Pandalai, Sankarasubramony and Menon (1958 a, b, 1959 a, b). The results showed that the affected soils were having low available potash, exchangeable calcium and magnesium, iron, total exchangeable bases, base exchange capacity, percentage base saturation and pH. They also suggested waterlogging as a main feature which predisposed the palms to diseased condition. Studying the nutritional and environmental factors associated with the disease, Verghese (1960, 1962) suggested that probably the minerological composition of the rocks and some toxic products of weathering could be responsible for the disease. He indicated the possibility of water as a carrier of parasitic or toxic products from one place to the other. Sankaranarayanan and Verghese (1961) and Ramanandan, Nambiar and Pandalai (1961) suggested that inadequate nutrition could be a contributing factor in the incidence of disease. Cecil and Verghese (1962) found that ferrous iron, manganese, sulphates, sulphites, sulphides, nitrates and ammoniacal nitrogen were only in traces in the sub-soil waters and water extracts collected from disease affected tracts indicating that these factors were not contributing towards disease incidence. Verghese Sankaranarayanan and Menon (1957, 1962 b) in a study on the toxic elements of soils from healthy and disease affected tracts found that the soils from both healthy and disease affected areas

/was absent. Injection experiments with cadmium contained only traces of strontium whereas cadmium/chloride on healthy palms showed that the trees wilted, but no characteristic symptom of the root (wilt) disease developed. Pillai and Pushpadas (1965) observed that coconut palms growing in 'Kari' tracts (peaty soil) having high acidity often ranging in pH from 3-4 had less incidence of disease. The survey of Pillai and Pushpadas (1966) has brought out that the disease was intense along river banks. According to them spread of the disease was slower in cases where the river water was more saline and acidic. Verghese (1966) observed that disease affected palms occurred along with healthy ones in all the major soil types viz. sandy, loamy, clayey and laterite. The results of his studies also indicated that moisture, loss on ignition and nitrogen were more in the soils of disease affected tracts suggesting that the combined effect of excess moisture and nitrogen might set in soil conditions conducive for incidence of disease. He also reported the status of calcium and magnesium to be uniformly low in all soil types irrespective of the condition of the palms. Faulty nutrient ratios, particularly K/Mg, K/Ca and N/K would also have some bearing on the disease incidence.

STUDIES ON TISSUES

Menon and Nair (1952) were the first to examine the major nutrient status of leaves in relation to root (wilt) disease of the coconut palm. The outer and middlewwhorls of leaf samples of the trees showing advanced stages of disease gave a much lower percentage of potash compared to the healthy. In the first reported study on micronutrients (Sankarasubramony et al, 1951), it was rather difficult to decide the role of manganese in the physiology of the coconut palm in relation to its health. Sankarasubramony et al (1952) showed that in general there was accumulation of nutrients in the leaves of disease affected palms and impaired physiological process. Pandalai (1962) noted higher content of potash and higher K/Mg ratio in the leaves of palms showing foliar yellowing conditions. Verghese et al (1962 a) found that major nutrients and silica accumulated in the leaf tissues of the disease affected palms. Discussing the data on the nutrient status of leaves of healthy and disease affected palms, they stated that excessive silica could be one of the factors responsible for the sporadic outbreak of root (wilt) disease in virulent form in certain situations with granite rock underlying within very short distance from the surface, sometimes even less than 30 cm. Spectrographic studies on the ash from healthy and affected palms revealed no difference

in B, Mn, Mg, Fe and Cu contents (Verghese, et al., 1962, b). They also ruled out cadmium and strontium toxicity (Verghese, et al. 1957; 1962, b). Cecil (1969, 1975) from his studies on leaf samples collected from disease affected area and a perfectly healthy area concluded that a lower status of Ca and Mg was associated with the disease affected conditions. Cecil and Pillai (1978) found that crown rot in coconut palms was due to boron deficiency which could be rectified by application of Boron. But this was not related to root (wilt) disease.

FERTILIZER TRIALS

The earliest report on fertilizer trials was on those started in 1940 at Kayangulam in two heavily infected gardens (Menon and Nair, 1952). The trials gave an indication that nitrogen and potash were the limiting factors in the experimental area. As per recommendations of Dastur and Thomas (1940), preliminary experiments were also carried out to obtain indications, if any, of deficiency of micronutrients. Diagnostic spraying with zinc sulphate, ferrous sulphate, boric acid and manganese sulphate was tried, but no response was obtained. From the coconut fertilizer scheme operated in the West Coast from 1952 to 1957 by the potash Scheme, India (Malye, 1956; John and Jacob, 1962), it was reported that in the root (wilt) disease affected area, continued application of NPK fertilizers along with pesticidal measures substantially helped to improve the condition of the palms and get yield response to some extent. Nair and Radha (1962) and Lal (1966) found improvement in the foliar conditions of disease affected palms by manuring and spraying trials with bordeaux mixture, Fe, Zn, B, Mo, Mn and Mg, while the condition of the palms under control treatment deteriorated. Chettiar, Verghese and Sankaranarayanan (1962) reported that application of wood ash for five consecutive years did not have any curative effect as indicated by observations on the morphological characters and visual symptoms of the disease. John, Channey and Verghese (1962) reported that application of chilean nitrate had no curative effect on the disease affected palms, but had beneficial effect on seedlings. Ramanandan and Pandalai (1962) reported ameliorative effect on palms showing foliar yellowing in a sandy tract due to application of Mo, B, Cu and Mn. Maximum effect was seen due to application of Mo. Pillai (1959), Davis and Pillai (1966) and Davis (1969) concluded from a micronutrient fertilizer trial that the application of micronutrients did not prevent fresh incidence of disease, but definitely helped to make the palms sustain themselves and give economic yield. Lal (1969) reported that yellowing generally

associated with root (wilt) disease might be due to a deficiency of magnesium. Yield data of the disease affected palms under different manurial experiments for 12 years at the Coconut Research Station Farm at Kayangulam (1950-1962) was examined by Sahasranaman, Radha and Pandalai (1964). Continuous application of NPK fertilizers for 12 years progressively improved the yield of palms affected by root (wilt) disease alone to the same extent as that in healthy in 5 years. On the other hand, in palms affected by both root (wilt) and leaf rot, the improvement recorded in the initial stage was not maintained and reduction in yield was also recorded. Analysis of the data, treatment-wise (healthy and disease affected palms considered together) indicated that the application of lime and farm yard manure besides NPK fertilizers was beneficial. The application of elemental sulphur, calcium sulphate or magnesium sulphate was found to increase the yield of disease affected palms. Slight improvement in foliar condition was also noted (Lal, 1966).

A few fertilizer trials involving Ca and Mg were in progress during the past few years and have yielded interesting results. A fertilizer trial with three levels of NPK and two levels of Ca and Mg on adult palms showed that the lowest dose tried viz. 350 g N, 300 g P_2O_5, 600 g K_2O and 500 g MgO per palm per year could be taken as an economic dose for coconut palms in root (wilt) affected areas. It was also seen that the disease could not be controlled/checked by application of NPK, Ca and Mg (Anon, 1978). In order to study the role of major nutrients (NPK, Ca and Mg) on the incidence and severity of root (wilt) disease, a fertilizer experiment with three levels of N, P and K and two levels of Ca and Mg was started in 1970 with newly planted WCT seedlings and the experiment has been in progress (Cecil, Pillai, Mathew and Kamalakshiamma, 1978; Anon, 1979). The higher levels of N, P and K had no additional effect over the first level viz. 500 g N, 300 g P_2O_5 and 1000 g K_2O on vegetative growth, onset of flowering or initial yields. The application of Ca was effective in increasing the rate of frond production and the number of functioning leaves and had some favourable influence on the onset of bearing, but it had no significant effect on initial yields. The application of 500 g MgO per palm per year had resulted in highly significant effect on all the vegetative growth parameters of young palms. It had a highly significant effect on the onset of bearing and the initial yields. The application of Mg helped the palms to flower on an average nine months earlier than palms that did not receive Mg. The mean yield of nuts/palm harvested in 1979 in the

absence of Mg was 42 while in the presence of Mg it was 57. It was found that the increase in the initial yield due to application of Mg was 37%. The incidence of disease increased progressively with the age of the palms and at the end of 1979, 35.5% of the experimental palms contracted the disease. None of the major nutrients or their interactions had any significant effect on the incidence of root (wilt) disease. However, the application of Mg had marked effect in preventing the decline in the initial yield of disease affected palms. A similar study on Dwarf x Tall hybrid palms with the application of three combinations of NPK, two levels of Ca and three levels of Mg started in 1972 on newly planted seedlings. The influence of Mg was pronounced even at the third year when seven per cent of Mg treated palms flowered (Kamalakshiamma and Pillai, 1980). By the eighth year 100% of the palms under the different treatments flowered whereas the palms under control treatment (No Po Ko) started flowering only by the seventh year. Eventhough increased yield was obtained at higher levels of fertilization, the lowest dose in the trial viz. 500 g N, 300 g P_2O_5, 1000 g K_2O with 500 g MgO which gave an average yield of 140 nuts/palm/year could be taken as the economic dose in the early bearing periods. Foliar yellowing and poor flower production were observed in all the palms grown without Mg. The incidence of root (wilt) disease was first noticed in the experiment at the fourth year. From 2% it rose to 8.9% by the eighth year. These recent fertilizer trials have thrown light on the economic fertilizer doses for adult and young WCT palms and DxT hybrids grown in sandy soils of the root (wilt) affected areas. These trials also showed that DxT hybrids are superior to WCT palms in bearing characters and are less susceptible to root (wilt) disease in the early bearing periods.

A critical study of the early work on soil and leaf analysis indicated that the data were inadequate in pinpointing factors, if any, associated with the disease since the number of samples collected was few and sampling sites were limited, not completely representing the healthy and disease affected tracts of Kerala. But the data gave indication that the major nutrients might not be related with the disease but imbalances of nutrients might be involved. Association of calcium and magnesium nutrition with the disease was also indicated. Data on micronutrient status were scanty. The studies with major nutrient fertilizers and very limited study with secondary and micronutrient showed that these were beneficial, but were not effective in preventing fresh incidence of disease or controlling the disease.

Taking all these factors into consideration and also the limitations of the earlier investigations, systematic and detailed nutritional survey was carried out recently, collecting soil and leaf samples with respect to healthy and disease affected tracts covering all the major coconut growing soils of Kerala (Pillai, Wahid, Kamala Devi, Ramanandan, Cecil, Kamalakshi Amma, Mathew and Nambiar, 1975). No consistent variation was observed in the N,P,K,Ca and Mg, S and exchangeable iron content of soils. Dithizone extractable zinc and active manganese were lower in soils from disease affected areas. Data on leaf analysis indicated that major nutrients were not related to disease incidence. Zinc and molybdenum followed by manganese, iron and boron were comparatively lower in leaf tissues of the affected areas. The difference in zinc content of both soil (0.9-2.4 ppm in healthy and 0.36-0.78 ppm in samples from disease affected areas) and leaf (20.3 ppm in healthy and 8.3 in palms from disease affected areas) was the most conspicuous of all. Imbalance of nutrient ratios like Fe/Mn and K/Mg was also evident. The results also revealed that 50% of the coconut soils of Kerala were below the threshold values for Zn, Mn and Mo. An intensive study of soil and plant tissues collected from the northern border of root (wilt) affected areas of Kerala showed that Ca and Mg in soil and tissues were not related to the incidence of disease (Mathew and Thomas Varkey, 1976). Since poor quality nuts with rubbery copra observed in certain palms in root (wilt) affected areas had lower status of Mg and Mn, a trial with foliar application of Mg and Mn was initiated in 1976. Significant improvement in hardness of copra was observed due to application of magnesium sulphate (Anon, 1980) In view of the fact that Zn and Mo were low in disease affected palms, foliar application of these nutrients were carried out for a period of five years in disease affected palms, but no response was observed (Anon, 1980). A systematic micronutrient manurial experiment consisting of all combinations of two levels each of Zn, Mn, Mo, B, Cu and Fe on newly planted WCT seedlings has been started during the year to find out whether application of any of the micronutrients singly or in combination could prevent incidence of disease.

Thus the results of investigations conducted so far point to the importance of more detailed investigations on the involvement of soil factors especially the trace elements in the incidence of root (wilt) disease. Apart from the field trials in progress, a micro level study of different soil parameters including geochemical and geohydrological aspects has been initiated.

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